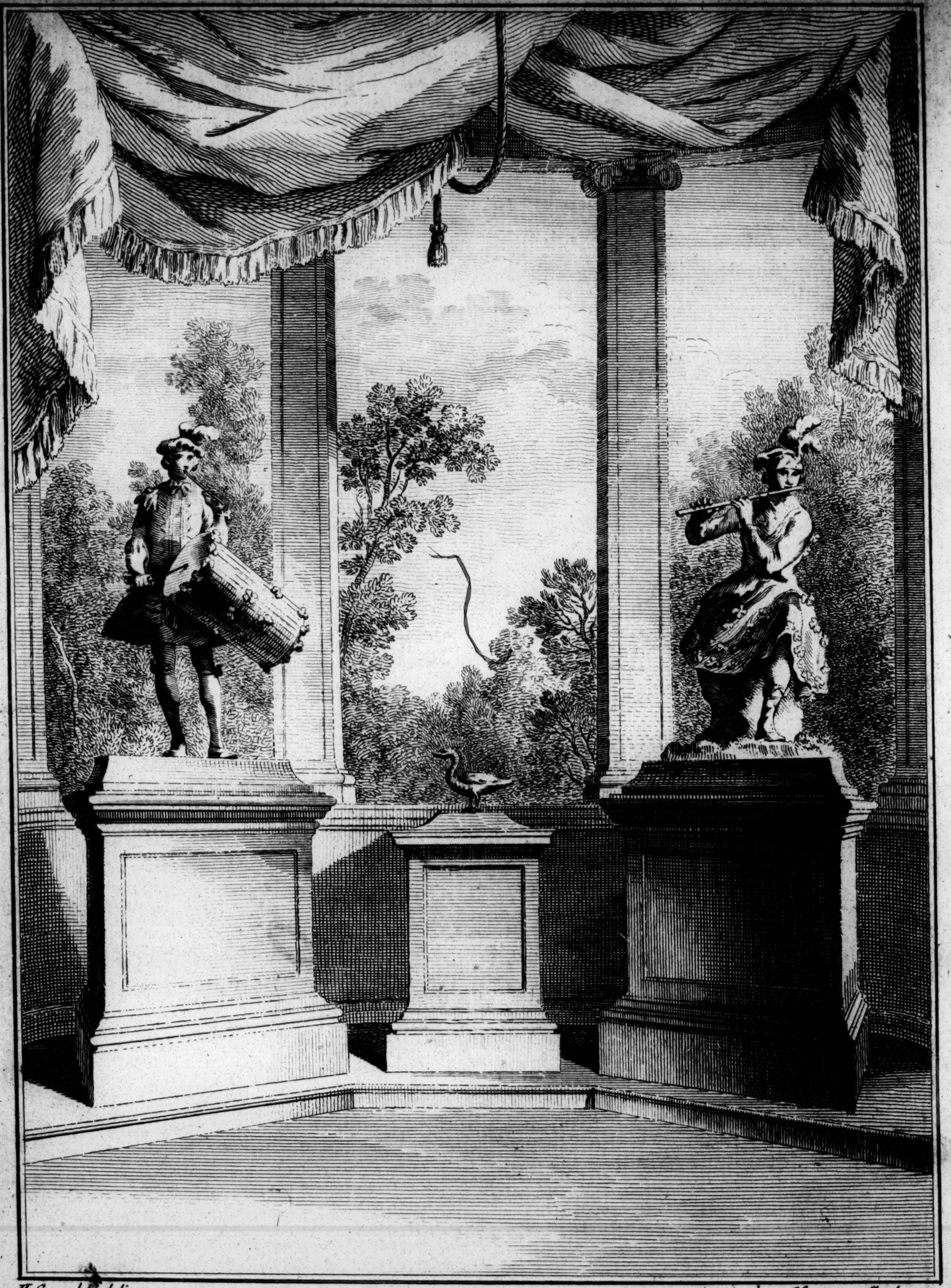

H. Gravelot, delin. *Vivares Sculp.*

AN ACCOUNT OF THE MECHANISM OF AN AUTOMATON, OR IMAGE playing on the *German-Flute*:

As it was preſented in a *Memoire*, to the Gentlemen of the ROYAL-ACADEMY of SCIENCES at *PARIS*.

By M. VAUCANSON, *Inventor and Maker of the ſaid* MACHINE.

TOGETHER WITH

A DESCRIPTION of an artificial DUCK, eating, drinking, macerating the Food, and voiding Excrements; pluming her Wings, picking her Feathers, and performing ſeveral Operations in Imitation of a living Duck: Contrived by the ſame Perſon.

AS ALSO

That of another Image, no leſs wonderful than the firſt, playing on the Tabor and Pipe; as he has given an Account of them ſince the *Memoire* was written.

Tranſlated out of the French *Original, by* J. T. DESAGULIERS, L.L.D. F.R.S. *Chaplain to his Royal Highneſs the* PRINCE *of* Wales.

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LONDON: Printed by T. PARKER, and ſold by Mr. STEPHEN VARILLON at the *Long Room*, at the *Opera Houſe* in the *Hay-market*, where theſe Mechanical Figures are to be ſeen at 1, 2, 5, and 7, *o' Clock* in the Afternoon. 1742.

The TRANSLATOR to the READER.

THOSE who have neither ſeen, nor heard a true Account of M. VAUCANSON's *Machines, may wonder that I ſhould take any Pains to promote the Advantage of Perſons who are expoſing any thing to publick View: As it would be very mean to cry up trifling Performances, and commend what amuſes the great and ſmall Vulgar, by Confederacy, ſuch as the pretended* Mathematicall Figures, *&c. But on the other hand, it is laudable to encourage thoſe who are truly ingenious, by doing Juſtice to the moſt curious Peices of Art that perhaps have ever been perform'd; which I cannot do better than by tranſlating into Engliſh this* Memoire *of Mr.* VAUCANSON, *that in a few Words gives a better and more intelligible Theory of* Wind-Muſick *than can be met with in large Volumes. And here the Reader will alſo find a clear Explication of every Part of his Contrivances, which requires no ſmall Skill to do with ſuch Perſpicuity, without Figures.*

In giving this Paper an Engliſh *Dreſs. I am ſtill acting in my Province, which has been for many Years to explain the Works of Art, as well as the* Phænomena *of Nature.*

J. T. DESAGULIERS.

P. S. *Whilſt this* Memoire *was printing, I received the Deſcription of the Duck and that of the Figure playing on the Tabor and Pipe; which Mr,* VAUCANSON *deſcribes in a Letter to a Friend. Therefore to do him Juſtice in every Reſpect, and for the Satisfaction of the Curious, I have ſubjoined the Tranſlation of his Letter.*

AN
ACCOUNT
OF THE
MECHANISM of an IMAGE
Playing on the *GERMAN FLUTE*, &c.

Preſented to the Gentlemen of the *Royal Academy* of Sciences,

By Mr. *VAUCANSON*, the Inventor of it.

GENTLEMEN,

LESS ſenſible of the Applauſe of the Publick, than deſirous of the Happineſs of deſerving yours, I come to diſcover to you, that it is only in following your Steps that I have been able to go on with ſome Succeſs in the Track I have purſued, for the Execution of my Undertaking. You will know your Leſſons in my Work. It is only raiſed on the ſolid Principles of Mechanicks, which I have taken from you.

To You I owe the Reflections I have made on the Sound of Inſtruments, on Mechanicks, and on the different Motion of the Parts wherewith Machines work. My Thoughts on the *German-Flute* will make the firſt Part of this *Memoire*: And in the Second, I ſhall do my ſelf the Honour to give a Detail of the Pieces contain'd in my Work, their ſeveral Motions, and their Effect.

FIRST PART.

My firſt Care has been to examine the Mouth of Wind-Inſtruments, to know well how to get Sound out of them, what Parts contribute to produce it, and how it may be modified.

You know, Gentlemen, that the Mouth of a *German Flute* differs from that of the other Wind-Inſtruments, ſuch as the common Flute, the Flageolet, and the Organ-Pipe; becauſe in theſe laſt the Wind introduced at a narrow Hole, but which is determined, ſtrikes the Parts of the Body of the Inſtrument which are immediately under it, as the Bezel; and by the Quickneſs of its Return, and its Re-action upon the ſmall Parts round about it, it ſuffers a violent Colliſion: Thus communicating its Vibrations to all the Parts of the Wood of the Flute, which in their Turn communicate them to the external Air round about them, it produces in us the Senſation of Sound.

But in the *German-Flute* the Mouth is undetermined, becauſe in that Inſtrument the Wind paſſes through a greater or ſmaller Iſſue, made by the greater or leſs Opening of the Lips, as they approach towards, or recede from each other; as they come nearer to, or are further from the Hole of the Flute; or as they advance more or leſs over the ſaid Hole.

All theſe Differences, which I reduce to four in the Mouth of the *German-Flute*, make it, in playing upon it, capable of a very great Number of Perfections, which are wanting in other Wind-Inſtruments, whoſe Mouth is determin'd; which I ſhall ſhew in explaining thoſe Motions.

The Sound being firſt produced by the Vibration of the Air, and the ſmall Parts of the Body of the Flute, is only determined by the Quickneſs or Slowneſs of thoſe Vibrations. If in an equal Time they are to be continued in a greater Number of the Parts of the Body ſtruck, they will loſe more of their Motion, and conſequently of their Swiftneſs; and thus, becoming ſlower in the ſame Time, they produce a leſs lively Sound; and this makes the deep or low Tones.

This happens when all the Holes of the Flute are ſtop'd. The Vibrations, which begin exactly at the Hole of the Mouth, muſt be communicated to all the Parts of the Wood at the ſame Time; therefore they are ſuddenly weaken'd, becauſe their Force is divided among a great Number of Particles; which will make the Flute give the loweſt Sound.

If you open the firſt Hole next the Bottom of the Flute, the Vibrations find an Iſſue ſooner, which interrupts their Continuation in the reſt of the Parts of the Body of the Flute: They have fewer Particles to ſtrike, (the Pipe being ſhortned by opening the ſaid Hole) thus, loſing a little leſs of their Force, becauſe there are now fewer Particles among which they muſt be divided, they will have a little more Swiftneſs; and being quicker in the ſame Time, they will produce a leſs deep Sound, and that will be a Tone higher. The other Tones will riſe gradually, as the upper Holes are unſtopp'd.

When you come to unſtop the Hole which is neareſt to the Mouth, that Hole dividing the inward Space of the Flute into two equal Parts, the Vibrations will find an Iſſue in the Middle of the Way that they are to run, to continue to the End of the Pipe; therefore they will go out with as much more Force and Velocity, having only half the Particles, among which they muſt divide themſelves; and conſequently will produce a Sound as high again, which will be the Octave. But as a Part of thoſe Vibrations is always communicated to the other half of the Body of the Flute, the Wind muſt be forc'd a little, to produce in thoſe Vibrations Accelerations, which by the Increaſe of their Motion will ſupply the Want of thoſe that are loſt in the other half of the Flute; then you will have a full Octave. That Note is alſo produc'd by ſtopping all the Holes of the Flute, as in that of the firſt Octave: But then you muſt double the Force of the Wind, to produce double Vibrations in the whole Body of the Flute, which amounts to the ſame Thing.

This is what is practiſed in the Tones of the ſecond Octave, where the Poſition of the Fingers and Opening of the Holes is the ſame as in the Firſt. You muſt blow with a double Force to produce double the Number of Vibrations in the ſame Time; which makes the ſecond Octave: Becauſe the more or leſs acute Sound conſiſts in the greater or leſs Number of Vibrations in the ſame Time.

Again, the Wind muſt be given with a triple Force to produce the third Octave; but Vibrations, ſo ſuddenly redoubled, not finding ſufficient Iſſue in the firſt Hole to hinder their going on in the reſt of the Body of the Flute, becauſe of their extreme Swiftneſs, we muſt be forced to open ſeveral Holes in the lower Part of the Flute; thus the Pipe being more open, the Vibrations will have a greater Iſſue and a full and open Sound will be form'd, without being oblig'd to give the Wind quite a triple Force.

By this changing of Openings, different from what is required in natural Sounds, an Iſſue may be given ſooner or later, and greater or leſs, to produce Semi-Tones; which muſt alſo be done in the laſt high Sounds, where a quicker and greater Iſſue muſt be given, that the

Vibrations may not loſe their Velocity in communicating with too many Parts of the Body of the Flute.

What remains is to ſhew how the Wind is modified, and what are the Parts in a living Perſon which contribute to give it more or leſs Force.

The Preſſure of Pectoral Muſcles upon the Lungs drives the Air out of the Veſicles that contain it: When this come up to the Mouth thro' the *Trachea Arteria*, (or Wind-pipe) it goes out of it by the Opening which the Lips form as they are applied to the Hole of the Flute. The greater or leſs Force of the Wind depends, firſt, upon the greater or leſs Preſſure of the Muſcles of the Breaſt, which drive it out of its Receptacle; ſecondly, upon the greater or leſs Opening of the Lips at its going out: So that when you wou'd blow weakly, the Muſcles then muſt act weakly, and the Lips making a large Opening, the Wind is driven ſlowly; and conſequently its Return producing Vibrations equally ſlow, and ſtill farther ſlacken'd by their Communication with all the Parts of the Wood of the Flute, low Sounds will be form'd.

But when you wou'd riſe to the Octave, that is, produce Sounds as high again, the Muſcles muſt act with a little more Force; and the Lips, coming nearer together, muſt a little diminiſh their Opening; then the Wind being more ſtrongly compreſs'd, and having a ſmaller Iſſue, will double its Swiftneſs, and produce double Vibrations, and thereby give Notes as high again, that is, the Octave. As you riſe gradually to the high Sounds, the Muſcles will act with more Force, and the Opening of the Lips will be proportionably contracted, that the Wind, driven in a more lively Manner, and forced to go out at the ſame Time by a ſmaller Iſſue, may conſiderably increaſe its Swiftneſs, and conſequently produce accelerated Vibrations, which make acute Sounds.

But the *German-Flute* (as I have already ſaid) having this Difference from other Wind-Inſtruments, that its Mouth is undetermined, the Advantages that ariſe from it, are that the Wind may be modulated by the greater or leſs Opening of the Lips, and by their different Poſition upon the Hole of the Flute, and by the Performer's being able to turn the Flute inwards or outwards. By this Means the Sounds may be ſwell'd and diminiſh'd, ſoften'd, and ſtrengthen'd, produce Echoes, and give Grace and Expreſſion to the Tunes that are play'd; which Advantages are not to be found in thoſe Inſtruments whoſe Mouth is determin'd: which I ſhall ſhew in explaining the Mechaniſm of the different Operations perform'd on the *German-Flute*

Sound conſiſting in the Vibrations of the Air produced by its Entrance into the Flute, and its Return upon that which ſucceeds it; if, by a particular Poſition of theLips, it enters into the whole Bigneſs of the Hole of the Flute, that is, goes thro' the longeſt Chord of the Hole, or the true Diameter of it, (which is done by turning the Flute outwards) then it ſtrikes a greater Number of the Particles of the Wood, and at its Return finding an Iſſue equally large, it communicates with a greater Quantity of external Air; and this produces the louder Sounds.

But when the Flute is turn'd inwards, the Lips cover more than half the Hole, the Wind going in thro' a ſmaller Opening, and being able to return only thro' the ſame, in order to communicate with the external Air, it can ſtrike only a leſs Quantity of it, which makes the Sound ſoft. Theſe two Differences may have ſeveral Degrees, which depend upon placing the Lips over a greater or leſs Chord of the Hole of the Flute, by turning it more inwards or outwards.

Therefore when there is Occaſion to ſwell a Note, firſt you turn the Flute inwards, that the Lips coming over the Edge of the Hole may ſuffer but a ſmall Quantity of Wind to go in or out, which then is driven weakly to produce a weak Sound; then inſenſibly turning the Flute outwards, the Lips allow of a greater Paſſage and Return to the Wind, which at that Time is driven with greater Force, that it may be communicated to a greater Quantity of Air, and there y increaſe the Sound; or diminiſh it anew, by inſenſibly turning the Flute inwards, as in the firſt Operation.

All theſe Variations of the Mouth may be perform'd in any one Sound whatſoever, whether it be an high or a low one; becauſe the Wind, tho' driven with different Degrees of Velocity during the Note that you wou'd ſwell to ſoften, muſt always be ſo regulated as to produce the Vibrations which determine that Note: In the Beginning, when the Sound will be weak, becauſe it will ſtrike a leſs Quantity of external Air, yet it will have Vibrations equal to thoſe that are produc'd in the Middle of the Note where the Sound encreaſes in Force, becauſe it will be communicated to a greater Quantity of Air; the Vibrations not being ſtronger or weaker on Account of their Velocity, but on Account of the Quantity of the Parts that they act upon, and which they put in Motion.

Wou'd you produce a ſoft Sound to repreſent an Echo? Place the Lips over the Hole quite to its Edge, by turning the Flute much inwards: then the Sound being able to be communicated but to a ſmall Quantity of external Air, thro' ſo ſmall an Hole, makes us hear a Sound that ſeems to be afar off, by its ſtriking our Organs weakly.

Theſe are Conveniences which cannot be found in Inſtruments whoſe Mouth is determined and invariable.

What remains to explain is that ſtroke of the Tongue, which is abſolutely neceſſary for playing on all Wind-Inſtruments.

The tonguing an Inſtrument is nothing elſe than a ſhort Interruption of the Wind, by the Interpoſition of the End of the Tongue in the Paſſage of the Lips.

Theſe, GENTLEMEN, have been my Thoughts upon the Sound of Wind-Inſtruments, and the Manner of modifying it. Upon theſe Phyſical Cauſes I have endeavour'd to found my Enquiries; by imitating the ſame Mechaniſm in an *Automaton*, which I endeavour'd to enable to produce the ſame Effect in making it play on the German Flute. The Parts which compound it, their Situation, their Connection, and their Effects, will be the Subject of the ſecond Part of this *Memoire*, as I firſt propoſed.

SECOND PART.

The Figure is about ſix Foot and an half high, ſiting upon a Piece of a Rock, placed on a ſquare Pedeſtal, four Foot and an half high, and three Foot and an half wide.

In the forepart of the Pedeſtal (the Pannel being open'd) on the right Hand there is a Movement, which by Means of ſeveral Wheels mov'd by a Weight, carries round underneath a ſteel Axel or Arbor, two Foot and a half long, with ſix Cranks in its Length at equal Diſtances, but looking different Ways. To each Crank are faſten'd Strings which terminate at the End of the upper Boards of ſix Pair of Bellows, two Foot and an half long, and ſix Inches wide each, placed at the Bottom of the Pedeſtal, where their lower Boards are made faſt, ſo that as the Arbor turns, the ſix Pair of Bellows riſe and fall ſucceſſively one after another.

In the hind Part of the Pedeſtal, above each Bellows, there is a double Pulley, whoſe Diameters are unequal, namely, one of three Inches and the other of an Inch and an half; which is done to give the Bellows a greater Riſe, becauſe the Strings joyn'd to them go round the great Diameter of the Pulley, and thoſe that are faſten'd to the Arbor which draws them, wind round the ſmall Diameter.

On the great Diameter of three of theſe Pullies on the right Hand, there are alſo wound three Strings, which, by Means of ſeveral little Pullies, terminate at the upper Boards of three Pair of Bellows placed in the upper Part of the Pedeſtal, before and at the Top.

Each String, as it ſtretches, when it begins to draw the Board of the Bellows, to which it is fix'd, moves a Lever placed above, between the Axis and the double Pullies in the middle Part of the loweſt Space of the Pedeſtal. That Lever, by Means of different leading Pieces terminates at the Valve of the lower Board of each Bellows, and keeps it raiſed, that the Air may go thro' without any Reſiſtance, whilſt the upper Board, as it riſes, encreaſes the Cavity of the Bellows. By that Means, beſides gaining Force, we avoid the Noiſe which that Valve commonly makes, as the Air cauſes it to tremble when it comes into the Bellows: Thus the nine Bellows are moved without any Shake, or Noiſe, and with but a ſmall Force.

Theſe nine Bellows communicate their Wind, in three different and ſeparate Pipes. Each Pipe receives that of three Pair of Bellows: The three which are in the lower Part of the Pedeſtal on the right Hand forwards communicate their Wind to a Pipe which runs up along the upright Piece of the Pedeſtal on the ſame Side; and theſe three Bellows are loaded with a Weight of four Pounds each: The three which are on the left Hand in the ſame

Row, give their Wind thro' a Pipe like the former, which riſes along the upright Piece on the ſame Side; and thoſe below are only loaded with two Pounds each: The three Pair of Bellows, which are in the upper Part of the Pedeſtal, give their Wind thro' a Pipe which runs horizontally under them, and are loaded only with the Weight of their upper Boards.

Theſe three Pipes, by different Elbows, end in three ſmall Receptacles in the Breaſt of the Figure. There, they re-unite into one, which goes up thro' the Throat, or Wind-Pipe, and widening makes a Cavity in the Mouth terminated by two Lips which bear upon the Hole of the Flute: Theſe Lips give the Wind a greater or leſs Iſſue, as they are more or leſs open; for the Performance of which, as well as that of coming forward or being drawn back, there is a particular Piece of Mechaniſm.

Within the forementioned Cavity there is a little moveable Tongue, which by its play can open or ſhut the Paſſage of the Wind that goes thro' the Lips of the Figure.

By this Mechaniſm has the Wind been conducted to the Flute; and by the following Contrivances it has been modified.

In the anterior Face of the Pedeſtal on the Left, there is another Movement, which by is Wheel-work, turns a Cylinder two Foot and an half long, and ſixty four Inches in Circumference: This Cylinder or Barrel is divided into fifteen equal Parts, of an Inch and an half each.

In the poſterior Face of the Pedeſtal in the upper Part of it, there is a Key-Frame, drawingor bearing on the Barrel, made of fifteen very moveable Levers, whoſe Ends on the Inſide have a little Nib or lifting Piece of Steel, which anſwers to each Diviſion of the Barrel.

At the other of theſe Levers are faſten'd Wires and Chains of Steel, which lead to the different Receptacles of Wind, to the Fingers, to the Lips, and to the Tongue of the Figure.

Thoſe which anſwer to the different Receptacles of Wind, are three in Number, and their Chains riſe perpendicularly behind the Back of the Figure, quite up to the Breaſt, where they end, being each fix'd to the Valve of one of the Receptacles: And this Valve being open, ſuffers the Wind to paſs into the Pipe of Communication, which riſes, as I have already ſaid, thro' the Wind-pipe into the Mouth.

The Levers which anſwer to the Fingers, are ſeven in Number, and their Chains alſo riſe perpendicularly quite up to the Shoulders; and there they make an Angle or Bend, to go thro' the upper Part of the Arm to the Elbow, where they bend again to run along the Arm as far as the Wriſt, where each of them ends in a Joynt fix'd to a Tenon made by the End of the Lever contain'd in the Hand, imitating the Bone which the Anatomiſts call *Metacarpos*, which, in the ſame Manner, makes a Joynt with the Bone of the firſt *Phalanx:* So that the Chain being drawn, the Finger may riſe.

Four of theſe Chains are inſerted in the right Arm to move the four Fingers of that Hand; and three in the left Arm for three Fingers, there being only three Holes which anſwer to that Hand.

The end of each Finger is arm'd with a Skin or Leather, to imitate the Softneſs of the natural Finger, that the Holes may be exactly ſtopt.

The Levers of the Key-Frame, which anſwer to the Motion of the Mouth, are four in Number: The Steel Wires which are faſten'd to them make Leaders to go to the Middle of a Ratchet within; and there are faſten'd to Chains, which riſe perpendicularly parallel to the Back-Bone in the Body of the Figure, whence paſſing thro' the Neck, they come into the Mouth, where they are faſten'd to thoſe Pieces, which being fix'd to the Lips within, give them four different Motions: The one opens them to give the Wind a greater Iſſue; the next contracts the Paſſage in bringing them nearer together; the third draws them back; and the fourth makes them advance over the Edge of the Hole.

There is but one Lever more upon the Key-Frame, to which is likewiſe faſten'd a Chain which riſes like the reſt, and ends in the Tongue, which is in the Cavity of the Mouth, behind the Lips, to ſtop the Hole, occaſionally, as I ſaid before.

Theſe fifteen Levers anſwer to the fifteen Diviſions of the Barrel, by their Ends which have the Steel Elbows or lifting Pieces, at an Inch and an half Diſtance from each other: When the Barrel turns, the Bars of Braſs fix'd upon its divided Lines meet with the lifting Pieces, and keep them raiſed a longer or a ſhorter Time, according as thoſe Bars are longer or ſhorter: And as the Ends of all thoſe lifting Pieces, make one right Line, parallel to the Axis of the Barrel, cutting all the Lines of Diviſion at right Angles; every Time that a Bar is fix'd at each Line, and that all the Ends of thoſe Bars make amongſt them alſo a right Line, and parallel to that which is form'd by the lifting Pieces of the Levers, each End of a Bar (as the Barrel turns) will touch and raiſe at the ſame Time the End of a Lever; and the other Ends of the Bars likewiſe forming a right Line parallel to the firſt, will, by the Equality of the Length of the Bars, each let fall its Lever at the ſame Time. One may eaſily ſee by this, how all the Levers may act, and at the ſame Time concur to the ſame Operation, if it be neceſſary.

When there is only Occaſion for ſome of the Levers to act, you place Bars only at thoſe Diviſions which anſwer to thoſe Levers which you wou'd have to move:

You may even determine the Time, by placing them nearer to or farther from the Line ſorm'd by the lifting Pieces ; and their Action may end ſooner or later, according to the different Length of the Bars.

The End of the Axis of the Barrel on the right Hand is terminated by an endleſs Screw with ſingle Threads, diſtant from one another a * Line and an half, containing twelve Threads, which make an Inch and an half in Length, equal to the Diviſions of the Barrel.

Above this Screw a Piece of Braſs is fix'd to the Pedeſtal Frame, which holds a Pivot of Steel of about one Line Diameter, that falls in between the Threads of the Screw, and ſerves inſtead of a Nut to it; ſo that the Barrel in turning is obliged to follow the ſame Direction as the Threads of the Screw, being guided by the Steel Pivot which is fix'd: Thus as the Barrel turns round, each Point of it will deſcribe a Spiral Line, and conſequently make a progreſſive Motionfrom Left to Right.

By this Means each Diviſion of the Barrel, determined at firſt under each End of a Lever, will change its Point at every Revolution, becauſe it will recede from it a *Line* and an half, which is the ſame Diſtance as the Threads of the Screw.

Therefore the End of the Levers faſten'd to the Key-Frame remaining unmoveable, and thoſe Points of the Barrel, to which they anſwered at firſt, moving away each Moment from the Perpendicular, by forming a ſpiral Line, (which by the progreſſive Motion of the Barrel, is always directed to the ſame Point, that is to the End of each Lever) it follows that the End of each Lever meets every Moment new Points upon the Barrs of the Barrel; which are never repeated, becauſe they form Spirals between them, which make twelve Turns upon the Barrel, before the firſt Point of the Diviſion can come under another Lever than that under which it was firſt determin'd.

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* A Line is the twelfth Part of an Inch.

It is in this Space of an Inch and an half that all the Bars are placed, which Bars themſelves alſo form ſpiral Lines, that the Lever (under which each of them muſt paſs during the twelve Turns of the Barrel) may act.

As one Line changes in Reſpect of its Lever, all the other Lines change in Reſpect of theirs; thus each Lever has twelve Lines of Bars of ſixty four Inches in Length, which all go under it, and which all together make a Line of ſeven Hundred and ſixty-eight Inches long. Upon this Line are fix'd all the Bars ſufficient for the Action of the Lever during the whole Play.

What remains is to ſhew, how theſe different Motions have contributed to produce the Effect which I propoſed in this *Automaton*, comparing them with thoſe of a living Perſon.

To make it produce Sound from the Flute, and form the firſt Note, which is *D* below. I begin firſt to diſpoſe the Mouth; for which End I fix upon the Barrel a Bar under the Lever, which anſwers to thoſe Parts of the Mouth that ſerve to increaſe the Opening of the Lips. Secondly, I fix a Bar under that Lever which ſerves to draw back thoſe Lips. Thirdly, I fix a Bar under that Lever which opens the Valve of that Receptacle of Wind, which is ſupplied by the ſmall Bellows that are not loaded. Laſtly, I fix a Bar under the Lever which moves the Tongue, to give a Stroke with the Tongue; ſo that theſe Bars in the ſame Time touching the four Levers, which ſerve to produce the foreſaid Operations, the Flute will ſound *D* below.

By the Action of the Lever, which increaſes the Opening of the Lips, the Action of a living Man is imitated, who increaſes that Opening for the low Sounds.

By the Lever which draws back the Lips, I imitate the Action of a Man who removes them farther from the Hole of the Flute, by turning it outwards.

By the Lever which gives Wind from the unloaded Bellows, I imitate the weak Wind which a Man gives, when he drives it out of the Receptacle of his Lungs, by only a light Compreſſion by the Muſcles of his Breaſt.

By the Lever which moves the Tongue, in unſtopping the Hole thro' which the Lips let the Wind paſs, I imitate the Motion of a Man's Tongue, when he pulls it back from the Hole to give Paſſage to the Wind to articulate ſuch a Note.

It will then follow, from thoſe four different Operations, that by giving a weak Wind, and making it paſs thro' a large Iſſue in the whole Bigneſs of the Hole of the Flute, its Return will produce ſlow Vibrations, which muſt be continu'd in all the Parts of the Body of the Flute, becauſe all the Holes will be ſhut, and, according to the Prinple ſettled in my firſt Part, the Flute will give a low Sound: and this is confirm'd by Experience.

If I wou'd make the Flute ſound the Note above, namely *E*, to the four firſt Operations for *D*, I add a fifth; I fix a Bar under the Lever, which raiſes the third Finger of the Right Hand to unſtop the ſixth Hole of the Flute; and I make the Lips to come a little nearer to the Hole of the Flute, by fixing or making a little lower the Bar of the Barrel which held up the Lever for the firſt Note, namely for *D*. Thus, giving an Iſſue to the Vibrations ſooner, by unſtopping the firſt Hole from the End, as I ſaid above, the Flute muſt ſound a Note above; which is alſo confirm'd by Experience.

All theſe Operations will be continued pretty nearly the ſame in the Notes of the firſt Octave, where the ſame Wind is ſufficient for forming them all. It is the different Opening of the Holes, by raiſing the Fingers, which characteriſes them: All that is requir'd is to fix on the Barrel Bars under the Levers which muſt raiſe the Fingers to form ſuch a Note.

In order to have the Notes of the ſecond Octave, we muſt change the Situation of the Mouth, that is, we muſt place a Bar under that Lever which ſerves to puſh the Lips beyond the Diameter of the Hole of the Flute, and thereby imitate the Action of a living Man, who in that Caſe turns the Flute a little inwards.

Secondly, we muſt fix a Bar under that Lever, which bringing the Lips towards one another diminiſhes their Opening; as a Man does to give a leſs Iſſue to the Wind.

Thirdly, a Bar muſt be fix'd under the Lever which opens the Valve of that Receptacle that contains the Wind coming from thoſe Bellows which are loaded with two Pounds; becauſe the Wind being then driven with more Force, acts in the ſame Manner as that with which a living Man blows by a ſtronger Action of the Pectoral Muſcles. Beſides, Bars muſt be plac'd ſo as to run under the Levers neceſſary to raiſe the Fingers requir'd.

From all theſe Operations it will follow, that a Wind driven with more Force, and going thro' a ſmaller Paſſage, will double its Swiftneſs, and conſequently produce double the Number of Vibrations; and theſe make the Octave.

As you riſe up to the higher Notes of this ſecond Octave, the Lips muſt ſtill be brought cloſer, that the Wind in the ſame Time may encreaſe its Velocity.

In the Notes of the third Octave, the ſame Levers that go to the Mouth act as in thoſe of the ſecond, with this Difference, that the Bars are a little higher: Which makes the Lips advance quite over the Edge of the Hole of the Flute, ſo as to leave but a very ſmall Hole. You muſt only add a Bar under that Lever which opens the Valve of the Receptacle which has its Wind from the moſt loaded Bellows, that is thoſe that are preſs'd down with four Pounds. Conſequently the Wind, blown with a ſtronger Compreſſion, and going thro' a Paſſage ſtill ſmaller, will increaſe its Velocity in a triple Ratio; whereby you will have the triple Octave.

In all theſe different Octaves ſome Notes are harder to produce than others; and then they muſt be managed by bringing the Lips over a greater or a leſs Chord of the Hole of the Flute, and by giving a ſtronger or a weaker Wind, which is the ſame that a Man does to ſound the ſame Notes, being oblig'd to manage his Wind, and to turn the Flute inwards or outwards, more or leſs.

It is eaſy to conceive that all the Bars fix'd upon the Barrel muſt be longer or ſhorter, according to the Time that each Note muſt have, and according to the different Situation neceſſary for the Fingers: which I ſhall not particularize here, leaſt I ſhould exceed the Limits of a ſhort *Memoire*, ſuch as I propoſed to give.

I wou'd only have it obſerved, that in ſwelling of Notes, I have been oblig'd, during the ſame Note, inſenſibly to ſubſtitute a ſtrong Wind to a weak, and a weaker to a ſtronger, and at the ſame Time to vary the Motion of the Lips; that is, to put them into the proper Situation for each Wind.

For a ſoft Sound, that is to imitate an Echo, I have been oblig'd to advance the Lips over the Hole of the Flute, and ſend a Wind ſufficient for forming ſuch a Tone; but whoſe Return, by ſuch a ſmall Iſſue as its Entrance into the Flute, can only ſtrike a ſmall Quantity of external Air; which, as I have ſaid, produces an Echo.

The Quickneſs and Slowneſs of different Airs have been meaſur'd upon the Barrel, by Means of a Lever; one End of which being arm'd with a Steel Point ſerv'd to mark the Barrel, as the Lever was ſtruck upon. At the other End of the Lever was a Spring, which immediately raiſed the Point up again.

The Movement was ſet a going, which turn'd the Barrel with a Velocity proportionable for the ſeveral Tunes.

At the ſame Time a Perſon play'd on the Flute the Tune whoſe Time was to be meaſured; whilſt another Perſon beat Time upon the End of the Lever, whoſe Point mark'd the Barrel, and the Diſtances between the Points prick'd on were the true Meaſure for the Tunes to be mark'd. Then the Intervals were ſub-divided into as many Parts as the Meaſure had Times or Bars.

The Fear of tiring you, GENTLEMEN, has made me paſs over a great many little Circumſtances, which tho' eaſy to ſuppoſe are not ſo ſoon executed: the Neceſſity of which appears by a View of the Machine, as I found it in the Practice.

GENTLEMEN, after having drawn from your *Memoires* the Principles which have guided me, it wou'd be no ſmall Satisfaction to me, if I could flatter myſelf to ſee you acknowledge, that I have happily applied thoſe Principles in the Execution of my Work. In the Approbation that you will deign to give it, I ſhall find the moſt glorious Reward of my Labour, and ſhall have greater Encouragement to purſue Hopes yet more flattering, which make my utmoſt Ambition.

An ABSTRACT of the Regiſter of the ROYAL-ACADEMY of SCIENCES.

April 30, 1738. N. S.

THE Academy having heard Mr. VAUCANSON's Memoire *read, containing the Deſcription of a wooden Statue, copied from the Marble* Faune *of* Coyſevaux, *that plays on the* German-Flute; *on which it performs twelve different Tunes, with an Exactneſs which has deſerv'd the Admiration of the Publick, and of which great Part of the* Academy *has been Witneſs; they have judg'd this* Machine *to be extremely ingenious, and that the Author of it has found the Means of employing new and ſimple Contrivances, as well for giving the Fingers of that Figure the neceſſary Motions, as for modifying the Wind which goes into the Flute by encreaſing or diminiſhing its Velocity,*

Velocity, according to the different Notes; by varying the Poſition of the Lips, and moving a Valve which performs the Office of the Tongue; and laſtly, by imitating by Art all that is neceſſary for a Man to perform in ſuch a Caſe. Beſides, Mr. VAUCANSON's Memoire *is written with all the Perſpicuity and Exactneſs that the Subject is capable of; which ſhews the Author's Skill and great Knowledge in the different Parts of Mechanicks. In Witneſs whereof I have ſign'd the preſent Certificate.* Paris, May 3, 1738. N. S.

FONTENELLE, Perpetual Secretary of the ROYAL-ACADEMY of SCIENCES.

The Approbation of the Royal Cenſor.

I Have, by Order of my Lord Chancellor, *read a Manuſcript entitl'd,* The Mechaniſm of an *Automaton* playing on the Flute, preſented to the Gentlemen of the Royal-Academy of Sciences, by Mr. VAUCANSON, Author of this Machine. *Mr.* VAUCANSON *explains in his* Memoire *thoſe phyſical Principles that he has employed for the Invention and Execution of his* Automaton, *which is one of the moſt wonderful Productions of Art: It imitates a true Player on the Flute ſo perfectly, that the Publick continues to ſee and hear it with Admiration. Therefore we believe that the Impreſſion of Mr.* VAUCANSON's Memoire *will be very uſeful to ſatisfy fully the Curioſity of the Publick.* Paris, June 12, 1738.

H. PITOT

Mr. VAUCANSON's Letter to the ABBE *De Fontaine.*

MY ſecond Machine, or Automaton, *is a* Duck, *in which I repreſent the Mechaniſm of the Inteſtines which are employed in the Operations of Eating, Drinking, and Digeſtion: Wherein the Working of all the Parts neceſſary for thoſe Actions is exactly imitated. The* Duck *ſtretches out its Neck to take Corn out of your Hand; it ſwallows it, digeſts it, and diſcharges it digeſted by the uſual Paſſage. You ſee all the Actions of a* Duck *that ſwallows greedily, and doubles the Swiftneſs in the Motion of its Neck and Throat or Gullet to drive the Food into its Stomach, copied from Nature: The Food is digeſted as in real Animals, by Diſſolution, not Trituration, as ſome natural Philoſophers will have it. But this I ſhall treat of, and ſhew, upon another Occaſion.*

The Matter digeſted in the Stomach is conducted by Pipes, (as in *in an Animal by the Guts) quite to the* Anus, *where there is a Sphincter that lets it out.*

I don't pretend to give this as a perfect Digeſtion, *capable of producing Blood and nutritive Particles for the Support of the Animal. I hope no body will be ſo unkind as to upbraid me with pretending to any ſuch Thing. I only pretend to imitate the Mechaniſm of that Action in three Things,* viz. Firſt, *to ſwallow the Corn*; ſecondly, *to macerate or diſſolve it*; thirdly, *to make it come out ſenſibly changed from what it was.*

Nevertheleſs, it was no eaſy Matter to find Means for thoſe three Actions, and thoſe Means may perhaps deſerve ſome Attention from thoſe that may expect more. They will ſee what Contrivances have been made uſe of to make this artificial Duck *take up the Corn, and ſuck it up quite to its Stomach; and there in a little Space to make a Chymical Elaboratory to decompound or ſeparate the Integrant Parts of the Food, and then drive it away at Pleaſure thro' Circumvolutions of Pipes, which diſcharge it at the other End of the Body of the* Duck.

I don't believe the Anatomiſts *can find any thing wanting in the Conſtruction of its Wings. Not only every Bone has been imitated, but all the Apophyſes or Eminences of each Bone. They are regularly obſerv'd as well as the different Joints: The bending the Cavities, and the three Bones of the Wing are very diſtinct. The* firſt, *which is the* Humerus, *has its Motion of Rotation every Way with the Bone that performs the Office of the* Omoplat, Scapula, *or* Shoulder-Blade*: The ſecond Bone, which is the* Cubitus *of the Wing, has its Motion with the* Humerus *by a Joint which the* Anatomiſts *call* Ginglymus; *the* third, *which is the* Radius, *turns in a Cavity of the* Humerus, *and is faſten'd by its other Ends to the little End of the Wing, juſt as in the Animal. The Inſpection of the Machine will better ſhew that Nature has been juſtly imitated, than a longer Detail, which wou'd only be an anatomical Deſcription of a Wing. To ſhew that the Contrivances for moving theſe Wings are nothing like what is made uſe of in thoſe wonderful Pieces of Art of the* Cock *mov'd by the Clock at* Lyons, *and that at* Straſburgh, *the whole Mechaniſm of our artificial* Duck *is expoſed to View; my Deſign being rather to demonſtrate the Manner of the Actions, than to ſhew a Machine. Perhaps ſome Ladies, or ſome People, who only like the Outſide of Animals, had rather* *have ſeen the whole cover'd; that is, the* Duck *with* Feathers. *But beſides, that I have been deſir'd to make every Thing viſible; I wou'd not be thought to impoſe upon the Spectators by any conceal'd or juggling Contrivance.*

I believe that Perſons of Skill and Attention, will ſee how difficult it has been to make ſo many different moving Parts in this ſmall Automaton; *as for Example, to make it riſe upon its Legs, and throw its Neck to the Right and Left. They will find the different Changes of the* Fulchrum's *or Centers of Motion: they will alſo ſee that what ſometimes is a Center of Motion for a moveable Part, another Time becomes moveable on that Part, which Part then becomes fix'd. In a Word, they will be ſenſible of a prodigious Number of Mechanical Combinations.*

This Machine, when once wound up, performs all its different Operations without being touch'd any more.

I forgot to tell you, that the Duck *drinks, plays in the Water with his Bill, and makes a gugling Noiſe like a real living* Duck. *In ſhort, I have endeavour'd to make it imitate all the Actions of the living Animal, which I have conſider'd very attentively.*

My third Machine, or Automaton, *is the Figure playing on the* Tabor *and* Pipe, *which ſtands upright on its Pedeſtal, dreſs'd like a dancing Shepherd. This plays twenty Tunes, Minuets, Rigadoons, and Country-dances.*

One wou'd at firſt imagine that the Difficulty in making of this has been leſs than in the Figure playing on the German-Flute. *But, without making a Compariſon between the two Machines, to praiſe one more than the other; I would have it obſerv'd, that here an Inſtrument is play'd upon, which is very croſs-grain'd and falſe in itſelf; that I have been forc'd to articulate Sound by Means of a Pipe of three Holes only, where all the Tones muſt be perform'd by a greater or leſs Force of the Wind, and half ſtopping of Holes to pinch the Notes: That I have been oblig'd to give the different Winds, with a Swiftneſs which the Ear can hardly follow; and that every Note, even* Semi-Quavers, *muſt be tongued, without which the Sound of this Inſtrument is not at all agreeable. In this the Figure out-does all our Performers on the* Tabor-Pipe, *who cannot move their Tongue faſt enough to go thro' a whole Bar of* Semi-Quavers, *and ſtrike them all. On the contrary, they ſlur above half of them; but my Piper plays a whole Tune, and tongues every Note. What a Combination of Winds have I been oblig'd to make*

ſor

for that Purpoſe? In carrying on my Work, I have made Diſcoveries of Things which could never have been ſo much as gueſs'd at. Cou'd it have been thought, that this little Pipe ſhou'd, of all the Wind-Inſtruments, be one of the moſt fatiguing to the Lungs? For in the playing upon it, the Performer muſt often ſtrain the Muſcles of his Breaſt with a Force equivalent to a Weight of 56 *Pounds: For I am oblig'd to uſe that Force of Wind, that is, a Wind driven by that Force or Weight, to ſound the upper* B, *which is the higheſt Tone to which this Inſtrument reaches: Whereas one Ounce only is ſufficient to ſound the firſt Note, or produce the loweſt Tone, which is an* E. *Hence will appear, how many different Blaſts of Wind I muſt have had to run thro' the whole Compaſs of the* Tabor-Pipe.

Moreover, as the different Poſitions of the Fingers are ſo few, ſome wou'd be apt to think that no more different Winds wou'd be neceſſary than the Number of Notes on the Inſtrument; but the Fact is otherwiſe: that Wind, for Example, which is able to produce a D *following a* C, *will never produce it, if the ſame* D *is to be ſounded next to the* E *juſt above it; and the ſame is to be underſtood of all the other Notes. So that upon Computation it will appear that I muſt have twice as many different Winds, as there are Tones, beſides the Semi-Tones, for each of which a particular Wind is abſolutely neceſſary. I own freely, that I am ſurpriz'd myſelf to ſee and hear my* Automaton *play and perform ſo many and ſo differently varied Combinations: And I have been more than once ready to deſpair of ſucceeding; but Courage and Patience overcame every Thing.*

Yet this is not all: This Pipe employs but one Hand; the Figure holds a Stick in the other, with which he ſtrikes on the Tabor *ſingle and double Strokes, Rollings varied for all the Tunes, and keeping Time with what is play'd with the Pipe in the other Hand. This Motion is none of the eaſieſt in the Machine; for ſometimes we muſt ſtrike harder, ſometimes quicker, and the Stroke muſt always be clean and ſmart, to make the* Tabor *ſound right. The Mechaniſm for this conſiſts in an Infinite Combination of Levers, and different Springs, all moved with Exactneſs to keep true to the Tune: But theſe wou'd be too tedious to give a particular Account of. In a Word, this Figure in its Contrivance is ſomething like that which plays on the* German-Flute; *but differs from it in many of the Means of its Operations.*

FINIS.